DESERT
PLANT LIFE

COMPARATIVE MORPHOLOGY OF THE FOLIAR APPENDAGES IN CERTAIN OF THE OPUNTIEAE

John Poindexter

ADRIAN HARDY HAWORTH

CRASSULA HOTTENTOTTA

H. Herre

PREPARING CACTUS FLOWERS FOR SHIPMENT

PERSONALITIES

Second Quarter -- April, 1951

Desert Plant Life Magazine

Official Publication AMERICAN SUCCULENT SOCIETIES
Chicago, Long Beach, Los Angeles

The oldest magazine in the English language devoted to the study of cacti and other succulents.

APRIL, 1951

VOLUME 23 NUMBER 2

WHOLE NUMBER 185

DESERT PLANT LIFE. Published Quarterly by the Desert Magazine Publishing Company, 866 South Grand Avenue, Pasadena 2, California. Entered as second-class matter October 14, 1930, at the Post Office at Pasadena, California, under the act of March 3, 1879. Yearly subscription price $1.50. In California 5 cents tax additional. Foreign countries, including Canada and Mexico, $2.00. Single copies 25 cents.

Address all communications to Box 68, Pasadena, California

Editor: ELLEN ROOKSBY

EDITORIAL CONTRIBUTORS

ELISE BERGER
LEON CROIZAT, D.J.
DR. E. YALE DAWSON
H. HERRE
GEORGE LINDSAY
REID MORAN, PH.D.
JOHN POINDEXTER, PH.D.
JACK WHITEHEAD

SECOND QUARTER

OPUNTIA TERES

JOHN POINDEXTER
Carlsbad, California

THE CACTUS SPINE AND RELATED STRUCTURES

The cacti have been of interest to horticulturists for several centuries, perhaps more because of the strange and bizarre modifications of the vegetative structure than because of the large and beautiful flowers they sometimes possess. It certainly is true that in this family of about two thousand species the changes in the vegetative organs have been pronounced and multitudinous while the flowers have been modified less often and to a slighter degree. The extent to which vegetative differences have been used in the taxonomy of the *Cactaceae* is indicative of this fact. Even the three tribes, the largest taxonomic divisions in the family, are based on vegetative characters. Consequently, the morphological interpretation of the vegetative organs is of great importance in determining the relations of the cacti, not only among the units of the family, but also with other families.

Morphological studies in the *Cactaceae* have been made intermittently for a period of a little over one hundred years, most of them being attempts to reconcile the cactus structure with the organization of the more typical flowering plants. However, the technical difficulties involved in sectioning cacti have tended to limit the scope of these investigations, and in some cases to impair the quality of the results. For this reason much of the earlier work is contradictory and incomplete with generalizations often based on one or two isolated examples. It is hoped that the present study will clear up some of the confusion regarding the nature of certain of the characteristic vegetative organs of the cacti.

I. STATEMENT OF THE PROBLEM

It is the purpose of this investigation to compare the structure and development of the apical and axillary meristems, the leaf, glochid, spine and spine-sheath in several species; and to provide a basis for the interpretation of the areole. While the morphology of each of these structures has been described one or more times previously, the more comprehensive observations to follow will correct certain misconceptions and substantiate other interpretations which previously were more or less unsupported by any real evidence.

Aside from demonstrating the homologies of some of the typical cactoid structures, the problem has considerable taxonomic importance because the structures studied are the principal ones used to separate the three tribes in the *Cactaceae*, and are frequently of importance in distinguishing genera and species. This is obvious in the following key.

KEY TO THE TRIBES OF CACTACEAE

A. Glochids present ..... *Opuntieae*
B. Glochids absent.
1. Leaves conspicuous ..... *Pereskieae*
2. Leaves reduced or invisible ..... *Cereae*

Since all of the vegetative structures mentioned above occur in the genus *Opuntia,* the present study is confined to that group.

The *Opuntieae* differ from the other cacti in the possession of glochids, which are distinct from spines in that they are smaller and more readily detached. However, in some of the Opuntias, there are glochids which are bigger than the spines in other species. It is important, then, to see if there is actually a real morphological difference between these structures since the presence of glochids is not always easy to demonstrate.

The North American members of the subgenus *Cylindropuntia* differ from the South American species in having spines which are covered by a loose, papery sheath. No investigation has ever been made regarding the origin of this sheath, although it is a very striking and almost universal structure in the northern group of cylindrical *Opuntias.*

The areole is probably the most characteristic vegetative structure in the *Cactaceae,* one occurring at each node, in the axil of the leaf. It generally consists of a pad of felt-like or bristly hairs from which develop and radiate the spines and glochids. In addition to these structures branch-stems and flowers always originate at areoles. These structures all develop from the meristems normally found in the axil of a leaf.

The description of the stem apices is probably not very important *per se,* but so little work from the modern point of view has been done on the zonal arrangements of the cells in the angiosperm apex that any accretion to the information now available is of value. In addition, several different types of Opuntias were used in the investigation, and it was felt that some differences of phylogenetic or taxonomic significance possibly might be found in the apices.

II. FORMS SELECTED FOR STUDY

Taxonomic considerations. According to the classical monograph *The Cactaceae* by Britton and Rose (7), the genus *Opuntia* is split into three subgenera according to the following key:

KEY TO THE SUBGENERA OF OPUNTIA

A. Joints all terete, elongated or short, cylindric to globose.
1. Branches several, many-jointed ..... *Cylindropuntia*
2. Branches 1 to few-jointed, the short joints usually clustered ..... *Tephrocactus*
B. At least some of the joints flat or compressed .... *Platyopuntia*

In this study the third subgenus, *Platyopuntia,* was omitted, partly because almost all of the preceding investigations had concerned themselves with species in this group and partly because all the structures being investigated can be clearly demonstrated in the sub-genera *Cylindropuntia* and *Tephrocactus.*

Cylindropuntia is a much larger and more diversified group than *Tephrocactus* with more than fifty species arranged in thirteen series according to Br. & R.'s Key. The characters in the key show clearly the consistency

in the appearance of papery sheaths in all the North American *Cylindropuntias* with the exception of the series *Clavatae*. However, even Britton and Rose noted that a few of the clavate Opuntias had sheaths on the young spines, and the present author has observed spine sheaths in at least half the species. Consequently, a real affinity between the *Clavatae* and the rest of the North American *Cylindropuntias* is demonstrable.

Britton and Rose suspected the *Clavatae* of being a transitional group between *Cylindropuntia* and *Tephrocactus,* but this seems rather far fetched, when the wide discontinuity in the distribution of the two groups is considered. The *Clavatae* are found only in Mexico and the southwestern United States, while the Tephrocacti are restricted to the high Andes in South America.

Since the time of Britton and Rose the subgenera of *Opuntia* have all been raised to generic rank by Backeberg (1), and a new genus, *Corynopuntia,* has been created from the *Clavatae* by Knuth (1).

HISTORICAL INTRODUCTION

The earliest morphological investigations of the *Cactaceae* were attempts to homologize the cactus spines with vegetative structures known elsewhere among the flowering plants. The results of these studies may be summarized under three headings:

1. Those in which the spines were said to be derived solely from the epidermis of the stem (Rudolph, 28; Velenovsky, 35).

2. Those in which the spines were classed noncommittally as emergences, i.e., structures derived from both epidermis and underlying tissues but not of a foliar nature (Caspari, 8; Schumann, 32; Chorinsky, 10).

3. Those which stated definitely that the spine is a reduced leaf or cataphyll (Zuccarini, 38; Treviranus, 33, in part; Kaufmann, 22; Delbrouk, 12; Vöchting, 36; Wetterwald, 37; Goebel, 18; Ganong, 17; Leinfellner, 23; Troll, 34).

Throughout the course of the investigations above it has become increasingly apparent that despite the lack of agreement at any given period (Chorinsky's paper was written as late as 1931), the third of these interpretations is the correct one. Furthermore, the fact that branch stems and flowers develop from the areole indicates that this structure is the seat of the meristematic tissue found in the axils of the leaves of all angiosperms. This is indeed the case, and many investigators have shown the axillary growing point embedded in the areole (Kaufman, 22; Goebel, 18; Ganong, 17; Wetterwald, 37; Chorinsky, 10; Leinfellner, 23; and Troll, 34). The spine and glochids are derived from this meristemic tissue in the same way in which bud scales and leaves arise from the axillary meristem in ordinary plants, and this is the basis for the hypothesis that the spines represent much reduced and sclerified cataphylls or foliage leaves. This theory is borne out to a certain degree by the fact that two investigators have found vascular bundles penetrating at least the basal portions of spines (Ganong, 17; Chorinsky, 10).

Transitions from spines to leaves and the existence of intermediate forms between spines and leaves have been emphasized by several authors (Kaufmann, 22; Goebel, 18; Ganong, 17; Leinfellner, 23; and Troll, 34). Goebel's experiment on *Pereskia grandiflora* is extremely interesting in this regard. He describes it as follows:

"Ich habe die Frage ob die Dornen umgewandelte Blattorgane sind

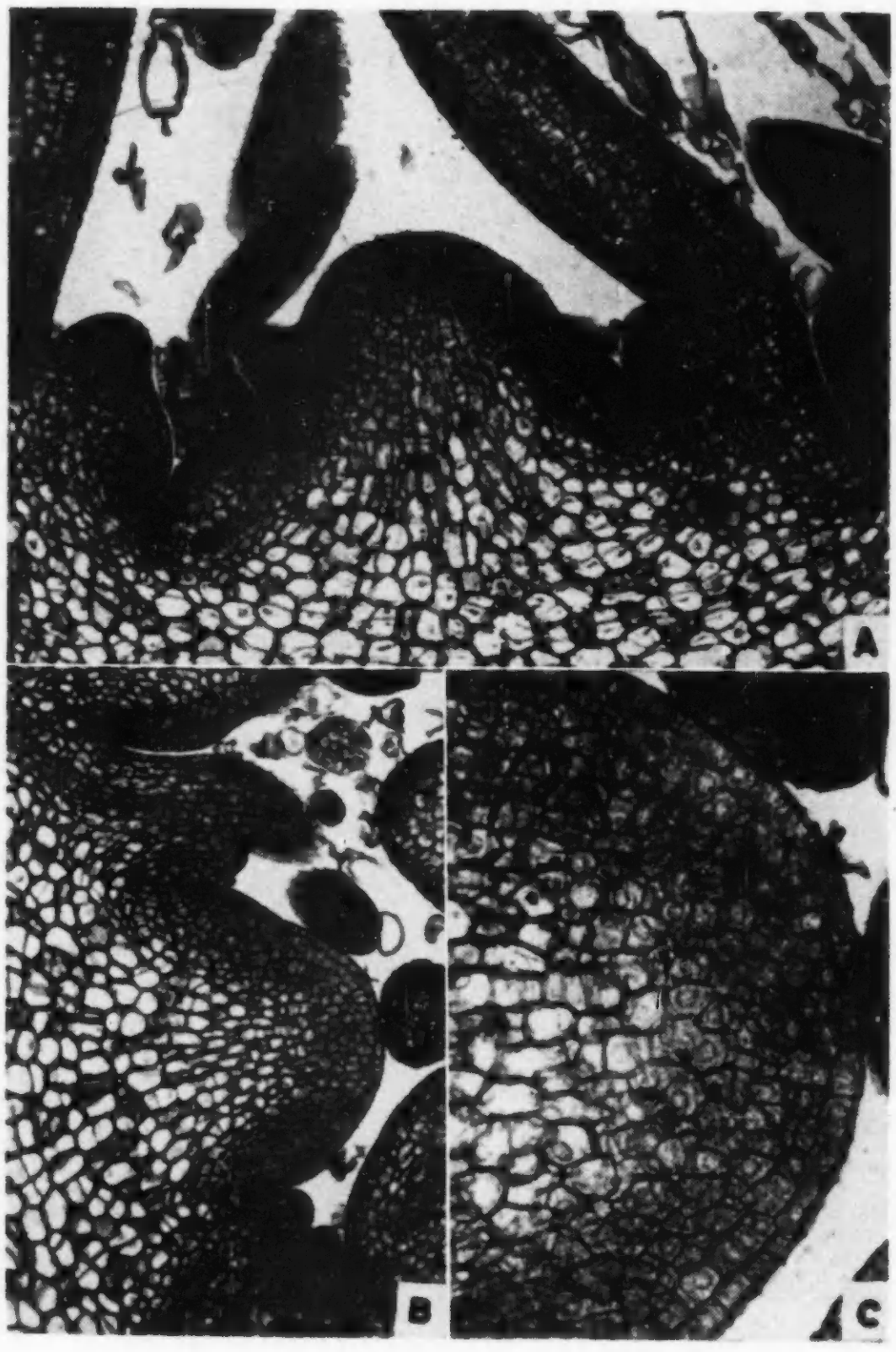


PLATE 2

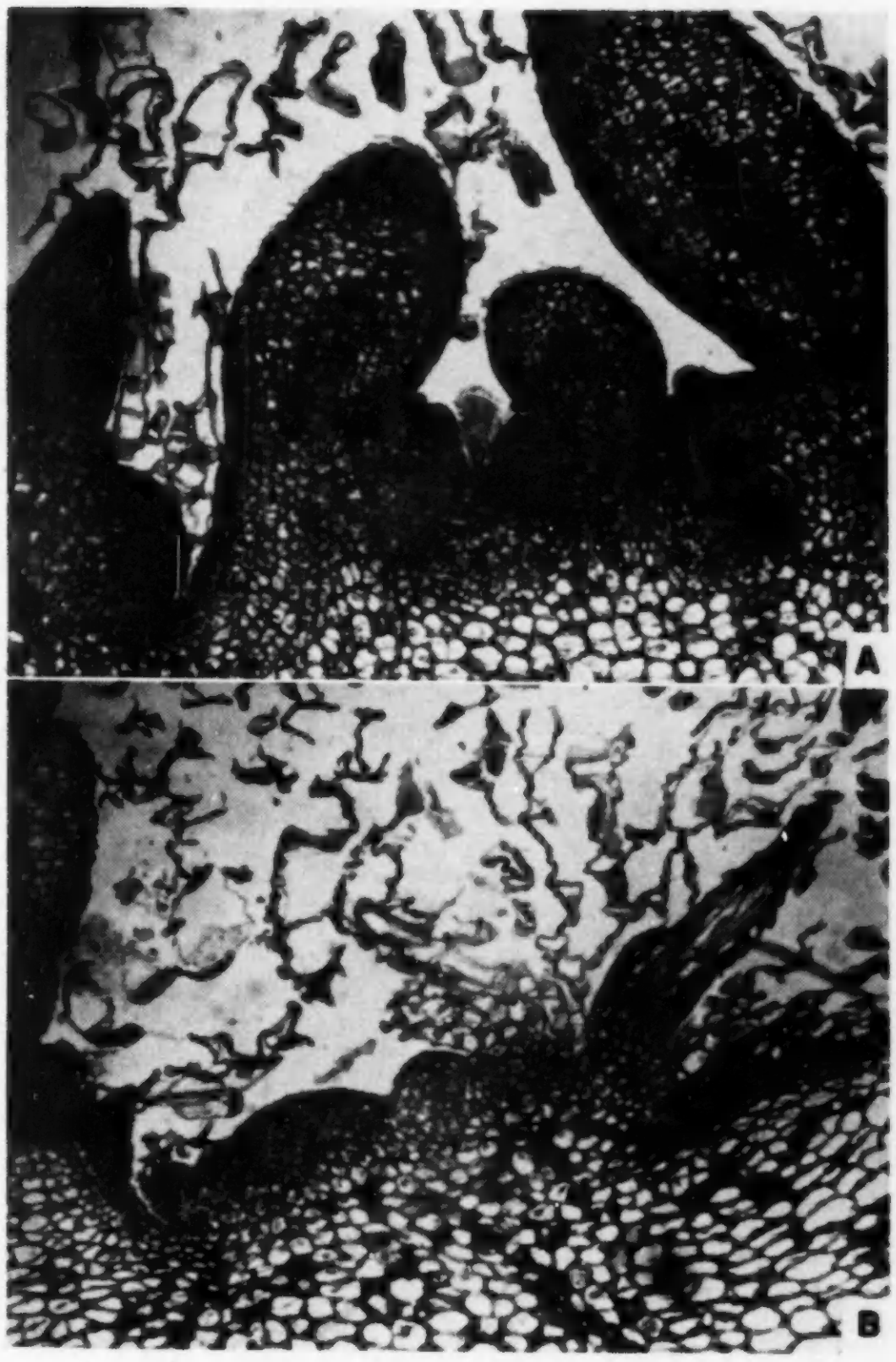


PLATE 4

experimentell zu lösen gesucht, indem ich oberhalb junger Blätter von *P. grandiflora* die Stammspitzesbeschnitt. Dadurch wird die Achselknospe dieses Blattes zum Austreiben angeregt, und sie bildet dann an Stelle der Dornen Blätter in derselben Stellung. Sind schon Dornen vorhanden und veranlasst man den Achselspross zum Austreiben so können die Dornen auseinanderrücken und in der Achsel eines Dornes ein Seitenspross auftreten, was beweist, dass die Dornen umgewandelte Blätter sind. . . ."

This experiment will be discussed later in the light of the evidence developed in the present research. The intermediate forms between spines and leaves described by Kaufmann (22), Ganong (17), Leinfellner (23), and Troll (34) are structures which have a hard and spine-like tip with a somewhat swollen and succulent base. It is claimed that the swollen base, which is indeed similar in shape to the base of one of the leaves, indicates the homology of spine and leaf. Apparently, chloroplasts are never found in even the soft parts of these spines.

Ganong (17) has speculated even further in his analysis of the situation which obtains when an areole begins to produce a new joint or branch stem:

". . . Wenn ein Achselvegetationspunkt von Opuntia aufhört Dornen zu erzeugen und anfängt Blätter zu bilden, so ist der Uebergang nicht plötzlich, sondern allmählig. Nach dem letzten Dorn kommt ein Gebilde, welches an der Basis etwas blattähnlich ist, darauf ein noch blattähnlicheres. Beim nächsten tritt schon die Spur eines Gefässbündels (Fig. 2) und einer Achselknospe auf, dann folgt ein Gebilde welches nur an der Spitze dornähnlich ist und ein gut entwickelte Achselknospe hat (Fig. 3), und schleisslich folgt ein typisches Blatt. . . ."

Again a discussion of these ideas will be postponed until after the results of the present research have been described.

Granting the foliar nature of the spines, the next question deals with the nature and homology of the areole. Leinfellner (23) and Troll (34), the two most recent authors to consider this problem both are of the opinion that the areole represents either a bud in which the cataphylls are reduced to spines and glochids, or a short lateral branch analogous to the spur shoot in Ginkgo, on which the leaves have been reduced to spines. Either of these interpretations would seem to fit the facts and a choice between them would be purely arbitrary. In any case it must be recognized that terminal growth can always occur at a higher rate with the formation of a flower or a branch stem.

The only argument against either of the above mentioned interpretations is that in many areoles the spines and glochids have an apparent dorsiventral rather than a radial arrangement with regard to the axillary growing point. This was the argument used by Schumann (32) when he negated the foliar homology of the spine. In considering this same problem, Ganong (17) showed that in some of the cacti the axillary growing point itself is considerably elongated in the dorsiventral direction. With the exception of the lowest spines, the remaining foliar appendages were radially arranged around the elliptical growing point. Troll (34) has further suggested that the eccentric spines first formed, which are always few in number, represent the prophylls of the vegetative or flower bud. The remaining spines and glochids could represent reduced bud scales or leaves, as suggested above, without further objection.

In spite of the taxonomic significance of the glochids mentioned pre-

viously, no thorough investigation of their relationships to spines has been made. Ganong (17) states that the glochids develop from the same type of primordia as spines and consequently are homologous with both spines and leaves. Most other authors omit discussion of the glochids or consider them as enlarged trichomes.

The trichomes of the cacti have been described several times from an anatomical viewpoint, but their ontogeny is virtually unknown. Caspari (8) stated that the trichomes are uniseriate, with the outer cells longer and broader than the basal ones. Caspari (8) and Ganong (17) note that the walls of the mature cells are variously pitted or striated. Ganong suggests that this is possibly correlated with the ability of the hair to absorb water. He also claims that spine sheath formation is an important function of the hairs in forms possessing sheaths.

The stem apex. The most satisfactory concepts of growth and differentiation at the stem apex have been developed since the histogen theory of Hanstein (19) was supplanted by Schmidt's (31) less committal tunica-corpus theory. The status of our knowledge on this subject in general has been reviewed recently by Foster (15, 16), and needs no further discussion here. No critical work on differentiation at the apices of cacti had been made until Boke's (5) investigations of *Opuntia cylindrica* and *Trichocereus spachianus* in 1941. The stem apices of both these species were very similar to most of the apices observed in the present investigation, and Boke's findings will be discussed with them.

MATERIALS AND METHODS

Collections of the species selected for this investigation were made from horticultural specimens in the gardens of Dr. R. W. Poindexter. Only the material of *Opuntia ramosissima* was collected in the field. Many cuttings of each species were rooted in the fall, and in the following spring the new joints were collected and fixed in a formalin-acetic acid-alcohol mixture. The best formula for this solution seemed to be as follows:

Formalin	5 cc.
Acetic acid, glacial	5 cc.
50 o/o Ethanol	90 cc.
Saponin	0.1 gm.

With the exception of the saponin, the formula above is identical with the one used by Boke (5), in his study of stem apices of cacti.

The fixations were dehydrated and embedded according to the tertiary butyl alcohol method (Johansen, 21). The materials were sectioned longitudinally at a thickness of seven microns and transversely at ten microns.

The slides were stained in Safranin and Fast Green according to the method outlined by Johansen (21).

The figures were all made with a Leitz Makam photomicrographic camera, using Eastman process panchromatic film and Wratten filter No. k2 or No. k3. The habit photographs were made with a Kodak Recomar 66 on Defender XF Panchromatic Film with no filter.

OPUNTIA TERES Cels *

This is a succulent plant (Plate 1) with light-green stems forming erect clumps 10-30 dm high. The leaves are terete, up to 2.5 cm in length and much more persistent than in the North American species of *Cylindropuntia.* The spines are sheathless, acicular and light grey in color. The flowers are

* Cels (9)

a deep reddish purple. This species is native in the Bolivian Andes at an elevation of about 4,000 meters.

The stem apex. The stem apex is very similar in most respects to that of *O. cylindrica,* described by Boke (5). In *O. cylindrica* the apex is a rounded dome at the summit of the stem. The tunica is composed of a single layer of cells which are considerably larger in the periclinal dimension than they are in the anticlinal. Three zones may be distinguished in the corpus. Just below the tunica at the very tip is a group of thick-walled, vacuolate initial cells, which are more or less isodiametric and dividing in all planes. Flanking the initial zone toward the sides of the apex is the generative zone which is composed of small, less highly vacuolate cells which are arranged more or less in rows parallel to the surface. Underneath the initial zone and generative zone lies the rib meristem with the large vacuolate cells lying in very definite rows parallel to the long axis of the stem.

The same zonation and types of cells are to be found in *O. teres* (Plates 1, 2). Perhaps the only difference is that the cells in the initial zone are not so conspicuously vacuolate as those described by Boke (Plate 2, Figs. A, B, C). Since the fixations were the same in both cases, it is possible that this difference arose from the use of a more concentrated solution of Fast Green. Vacuoles certainly were present in these cells. As far as could be ascertained, all the cells in the initial zone were uninucleate.

Leaf differentiation. Leaf primordia develop from the sides of the apical hump in a completely typical manner. The tunica and the first four or five cell layers in the generative zone of the corpus are involved (Plate 5, Figs. A and B). As the leaf continues development, the cells become stratified in rows parallel to the longitudinal axis. The uniseriate tunica forms the epidermis and the cells derived from the corpus develop into the mesophyll, which in this species is relatively compact. Only a few mucilage cells develop (Plate 6, Fig. B), in contrast to the more xerophytic North American species. *O. teres* growing at an elevation of about 4,000 meters is obviously not exposed to the extreme heat found on our southwestern deserts.

The growth of the primordium remains general until the primordium has reached a considerable size (Plate 5, Fig. B; Plate 2, Fig. A). As the leaf tissues start to mature, there is an invagination of the epidermis of the leaf primordium dividing it into two sections, the leaf base and the leaf. This invagination is usually more pronounced on the abaxial side. When abcission occurs it takes place at the narrowist point of this invagination, leaving the leaf base as a tubercle. While the differentiation is going on, there is a gradual diminution of cell division in the central part of the leaf, embryonic cells becoming restricted to the intercalary region between the leaf and leaf base, and to the epidermal and sub-epidermal layers of cells (Plate 2, Fig. A). Much of the final growth of the leaf is of course, accomplished by a tremendous increase in cell size, but some of it is the result of superficial growth and intercalary growth from the regions just mentioned.

Development of the axillary meristem. The axillary meristem differentiates at an early age (Plate 2, Figs. A, B; Plate 4, Fig. A), and, in fact, the cells of this region are a continuation of the cells of the generative zone of the apex. The development of axillary structures begins almost immediately, and spine primordia are visible while the leaves in whose axils they appear are still composed of cells in the embryonic condition (Plate 2, Fig. A;

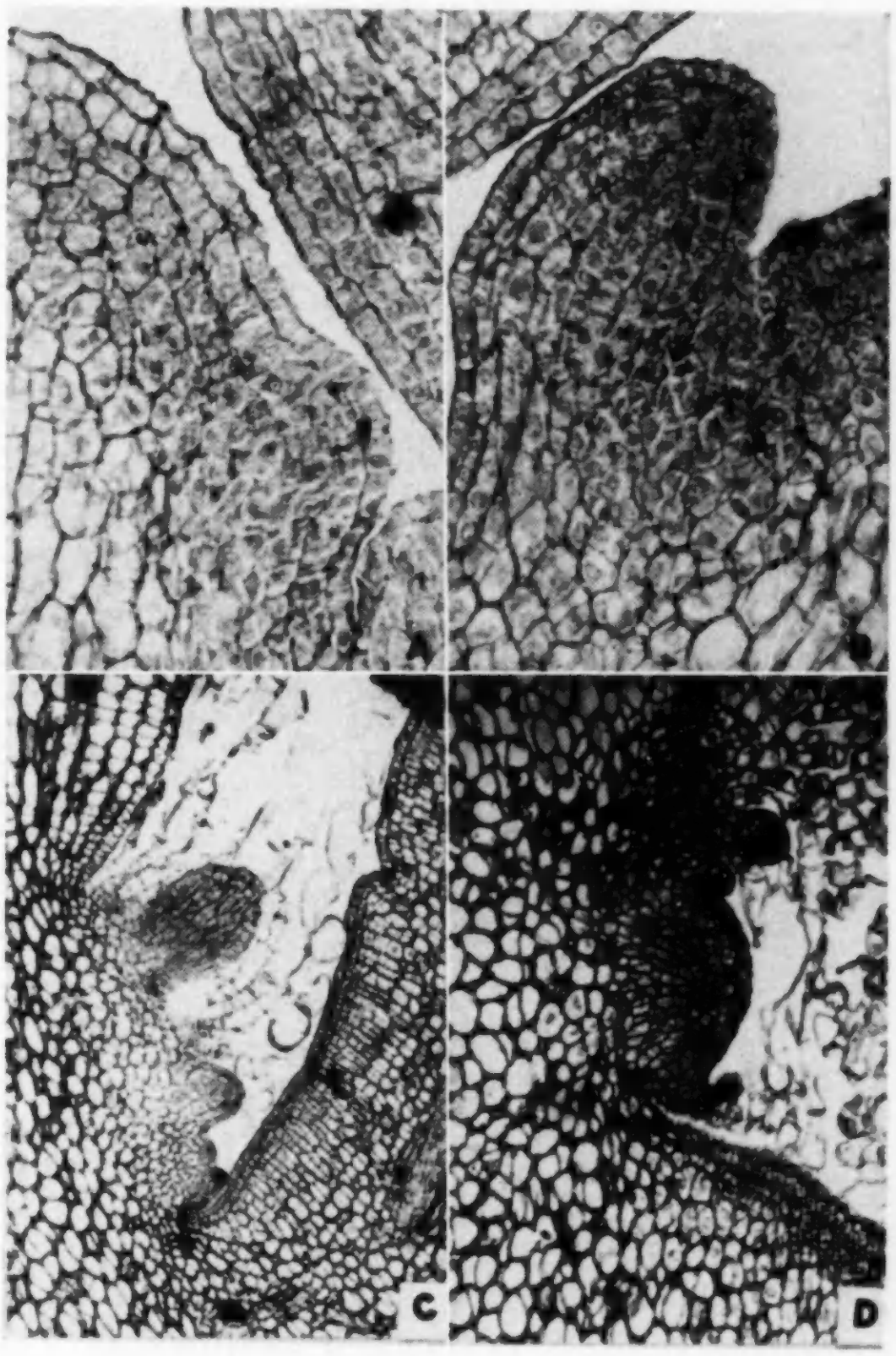


PLATE 5

Plate 4, Fig. A). The first two structures produced from the axillary meristem become large spines. These are produced in rapid succession from the outer side of the meristem. Subsequently, the meristem becomes more symmetrical and primordia develop acropetally on all sides in the normal manner (Plate 5, Figs. C and D; Plate 4, Fig. B). The spines develop from upwellings of tissue involving the uniseriate tunica and four or five layers of the underlying meristemic tissue. The latter is derived directly from the generative zone of the stem-apex as noted above. The cells of the spine primordia mature very rapidly from the tip toward the base, the internal cells becoming greatly elongated and sclerified fibers, and the epidermal cells becoming similarly elongated, but with the walls thickened mainly on the external surface (Plate 5, Fig. A; Plate 7, Figs. B and C). Continued growth in the length of the spine is accomplished by an intercalary meristematic region near the base of the spine. The cells in the intercalary meristem are small and remain embryonic for a long time after the tip of the spine has become completely mature.

Development of the glochids. In addition to the spines numerous glochids are produced by the axillary meristem. The glochid primordia (Plate 4, Fig. B; Plate 5, Figs. C and D) are very similar to those of leaves and spines, and throughout their growth the spines and glochids behave in an identical manner (Plate 4, Fig. B; Plate 5, Figs. C and D; Plate 6, Figs. B, C, and D; Plate 7, Fig. A). As a matter of fact, throughout this investigation it proved impossible to find any universal distinctions between spines and glochids. Both are derived in the same way from the axillary meristem, both develop basipetally while still growing in length from the intercalary meristem at the base, and both have essentially the same type of cells which are arranged similarly (Plate 6, Figs. A, B, and C); Plate 7, Figs. B and C). For a time it seemed as if spines might differ from glochids in the possession of vascular strand which penetrate their bases. These were figured for *Opuntia vulgaris*[1], *Opuntia* sp.[2], *Nopalea coccinellifera*[3] and *Pereskia sacharosa.* However a vascular strand was found penetrating the base of a spiny structure only once during the course of the present investigation, and in this instance the structure involved was a glochid. Consequently, in *Opuntia teres* the distinction between spine and glochid is a purely arbitrary one, these structures intergarding in size and being identical in all other respects.

The trichomes. The trichomes generally appear in tufts arising from about the bases of the spines. They are uniseriate, but with their bases touching and forming an almost solid tissue. They are definitely epidermal in origin (Plate 5, Figs. C and D; Plate 6, Fig. D), and increase in length through the activity of an intercalary growing region a few cells long at the base of each hair. The cells in this growing region are much shorter, somewhat narrower, and contain much more cytoplasm than the mature cells farther out on the hair.

1. Kaufmann (22)
2. Ganong (17)
3. Chorinsky (10)

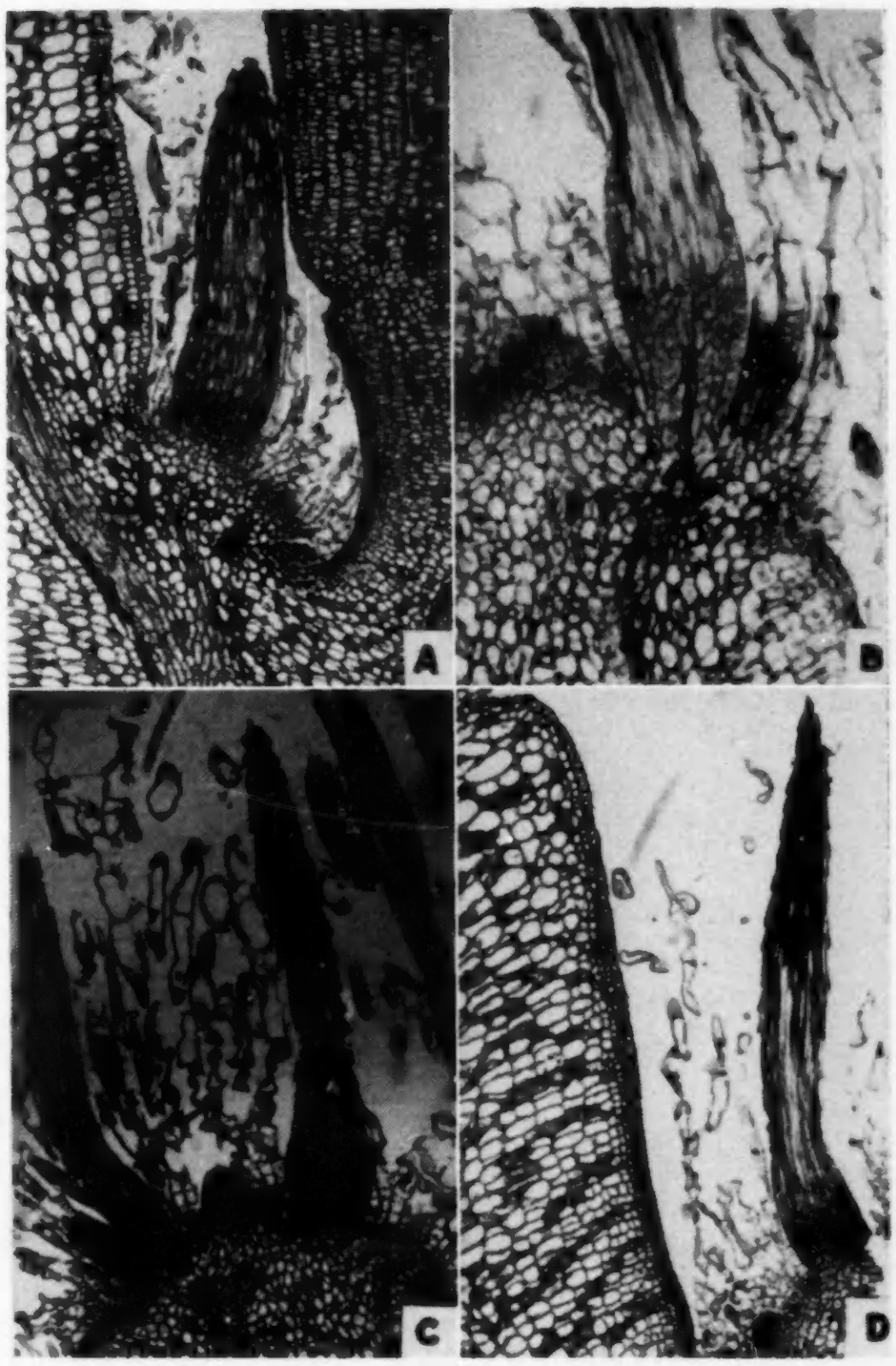


PLATE 6

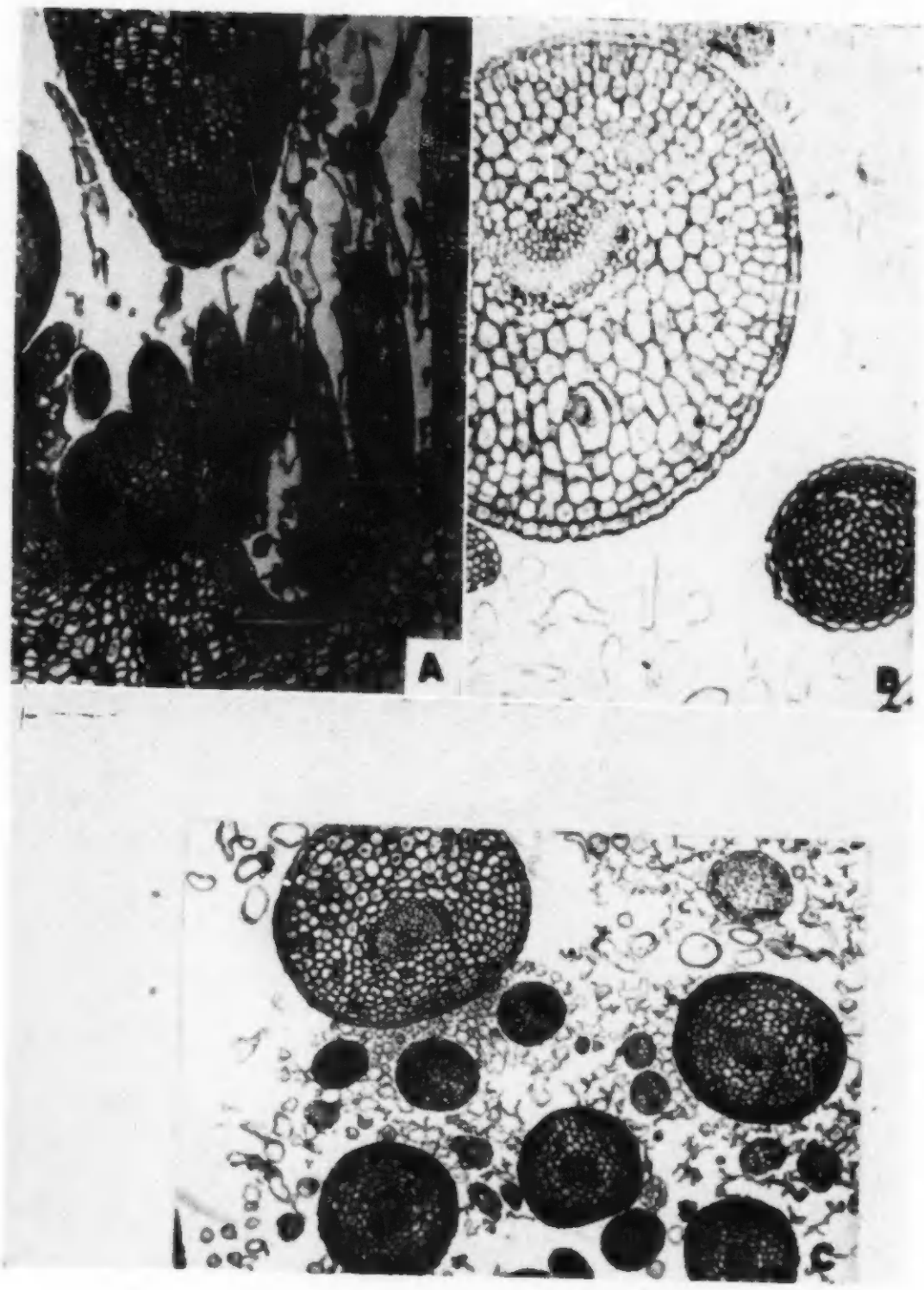


PLATE 7

ADRIAN HARDY HAWORTH
(1767-1833)

The great popularity of Haworthias has made their admirers wish to know something more about the man for whom they were named. Even a brief study of his life and contemporaries ought to add greatly to the enjoyment of the plants themselves.

The golden age of botany, at least that part pertaining to succulent plants must have been during the life time of Adrian Hardy Haworth. With a world of new plants constantly arriving from South Africa and the Americas—what a paradise for those possessing a taste for descriptive writing. A combination of favorable circumstances which seem ideally perfect fell to the lot of Haworth, the enviable opportunity of choosing for himself the life that he wanted.

It had been planned that he enter the legal profession, but his preparation having been completed, he renounced his previous intention for the study of entomology, ornithology and botany.

After taking up his residence, both in Cottingham and Chelsea on two different occasions he finally made Chelsea his home. Here he had one of the finest private gardens in all England and assembled the first important cactus collection of his time. Besides cultivating the succulent plants (which came from Kew) on his estates, he assisted in forming and arranging a botanical garden for Hull, his birthplace.

He became associated with P. DeCondolle and Redoute in France and Salm-Dyck in Germany, and together these vibrant spirits present a period unsurpassed for enthusiasm and productive labor.

At the age of 31, Haworth was elected a fellow of the Linnean Society and a few years after became one of the leaders in establishing the Entomological Society of London, which later became merged with the Zoological Club of the Linnean Society.

Besides his numerous contributions on entomological subjects he wrote on *Rhus toxidendron,* a "Revision of Narcissus" and an "Enumeration of the Saxafrages". He even wrote a poem once of twenty-four cantos, parts of which were published in a local paper. The sixth volume of Andrew's "Botanical Respository" was his work. But it is his connection with succulents that concerns us most. Schumann states he was the first writer of prominence to produce a number of authoritative works on this subject. He made the first attempt to monograph *Aloe* in the *Transactions of the Linnean Society*. The new plants sent from South Africa to Kew were studied there by Haworth and the results published in the papers, twenty-five in number, in Taylor's *Philosophical Magazine.* These publications have become so rare that even Kew does not possess a complete set. "Dissertationes variae", six numbers, comprising 204 pages were on botanical subjects, mostly references to succulent plants.

His works include "Observations on the Genus Mesembryanthemum",

in two parts (so reads the title page). "Part the second containing an arrangement of the Species after a new plan. Scientific Description of them. The synonyma of Authors, and a great variety of Critical, Philosophical and Explanatory Remarks, by Adrian Hardy Haworth, late of Cottingham, Yorkshire, now of Little Cheslea, Middelsex. MDCCXCV."

Of the original, only three copies exist, one at the British Museum. In 1931 Mr. Cox, Editor of *Flora and Silva,* wrote they were worth £50-70 or $250.00-$350.00 each. At the Los Angeles Museum a manuscript copy of this work was recently exhibited by DESERT PLANT LIFE, along with other rare and out of print material. In sending this copy from her husband's library, Mrs. Berger wrote: "A friend of Mr. Berger's, a great lover of succulents, took the trouble to go daily to the British Museum to copy the 'Observations' to facilitate Mr. Berger's study on Mesembryanthemum. He was believed to be some prominent scientist till it transpired that this amateur, intent to assist all in his power, was by profession, a cook or rather *chef de cuisine*". But this little book of 238 pages, 4½ x 7 inches, written in long hand and simply bound, has at present, an appraised value of RM 180-250!

Haworth's chief botanical work, however, was "Synopsis plantarum succulentarum". It was arranged on the Linnean system and gave in Latin, the descriptions, habitat, date of introduction and month of flowering of each species. This appeared in London in 1812, being followed some seven years later by a supplement and two years after that by "Revisiones plantarum succulentarum" of 207 pages.

Mammillaria and *Epiphyllum* were two genera established by Haworth, raising the number of cactus genera to six. His descriptions include: *Pilocereus* 2, *Rhipsalis* 6, *Opuntia* 18, *Echinocactus* 2, *Mammillaria* 12, *Epiphyllum* 4, *Cactus* 11, *Cereus* 28. Among the STAPELIEAE he established *Duvalia* and *Pectinaria* and described more than a dozen species. Among the Kleinias placed to his credit are: *K. articulata, ficoides, radicans, repens, tomentosa, neriifolia.* His descriptions are found among the Kalanchoes, Cotyledons, Agaves, Anacampseros. In the Sempervivum group, *Monanthes,* a genus established by him still stands.

Crassulas did not especially attract him though he cultivated a number of them and wrote about them. Least of all was he interested in the only succulents, the Sedums, native to his own country. More frequently we find his name among Euphorbias: in the index, Berger's "Sukkulente Euphorbien" 29 times as author. At La Mortola of the 41 Haworthias listed as grown there, 25 were named by Haworth and of the 36 Gasterias, 22 were given their names by this same botanist.

In one list of Mesembryanthemums his name occurs 112 times, in another list of eight and a half pages, the number of times Haworth's name is mentioned is 354 times.

After his sudden death from cholera at the age of sixty-six, his collections, both of insects and plants met the tragic fate with which we have become all too familiar, and were sold at auction. The insects numbering 40,000 were catalogued by a professor of zoology at Oxford, 1100 butterfly and moth species and 300 varieties being included. The type specimens described by him are in the British Museum.

His herbarium comprising 20,000 specimens is at Oxford. Eventually

California Personalities

At the June commencement, University of California, Berkeley, the Department of Botany gave the Doctor of Philosophy degree to Reid V. Moran. Subject of thesis "Revision of Dudleya."

As a valued contributor to DESERT PLANT LIFE since his early teens, Dr. Moran's authoritative and well considered style, his writings have brought to the reader much enjoyment and lasting value; not only through these columns but in the larger field of American botanical literature.

He leaves in the fall for Bailey Hortorium, Cornell University, Ithaca, New York, where he will assist in the preparation of Hortus III, a concise dictionary of gardening and general horticulture; another Liberty Hyde Bailey publication.

Receiving the advanced degree at the same time, was Robert Rodin, botanist of the South African Expedition, chronicled in DPL, September, 1948. His address for the next few years is Foreman College, Lahore, Pakistan, where he will be teaching botany.

A third, Bruce Zobel has been assigned to forestry at the Agricultural and Mechanical College of Texas, College Station, Texas.

In the series on "Outstanding local horticulturists" in *California Garden* for April is presented, with photograph "Meet Ethel Bailey Higgins,"

---

some of the living plants became part of the collection belonging to W. Wilson Saunders, one of the leading naturalists in England, and publisher of *Refugium Botanicum*. While in his teens, N. E. Brown made a visit to this garden and later came as Curator, remaining six years. He is said to have received great inspiration in working with the plants originally from Haworth's own collection. Even reading about it quickens one's appreciation of the great care these plants must have received at the hands of this illustrous trio, Haworth, Saunders, Brown, to have survived more than thirty years. This is no more of a tax on one's credulity than Berger's statement in 1908 that Aloes, collected by Thomas Cooper (1858-62) were still living at Kew Gardens fifty years later.

Haworth's commemorator, George Simonds Boulger, professor of botany at the city of London College and himself a writer on botanical subjects, gives this estimate in summing up his achievements. "Tho he never traveled beyond his own country, he was a sound naturalist on all subjects and his contributions to science are of lasting value."

In all respects we find in him exemplified the highest type of amateur. What Engelmann another amateur did in our own country to advance the knowledge of cactus, Haworth, in England, accomplished for succulents in general.

Ellen Rooksby

author of "Our native Cacti." As present curator she has helped build the herbarium from a few thousand to the considerable size of 45,000 specimens. She will celebrate her 85th birthday next month.

"Comparative morphology," a portion appearing in this number, is part of a dissertation submitted to the Department of Biology, and the committee on graduate study of Stanford University by the author as part of the requirements for the degree of Doctor of Philosophy. He is the son of Dr. Robert W. Poindexter active in cactus circles in former years.

Horticulture for May carries an illustrated account of "William Hertrich, the dauntless gardener" written by Alfred C. Hottes. The occasion was the presentation of the George Robert White Medal of Honor from the Massachusetts Horticultural Society given each year to an outstanding American horticulturist.

The trustees of the Huntington Library sponsored a luncheon at which the medal was presented to Mr. Hertrich Curator Emeritus of Huntington Botanical Gardens. It contains the largest outdoor collection of cacti and other succulents in the world.

Incidently this is the second time this medal has been bestowed upon a succulent authority, the other recipient being W. A. Manda of New Jersey.

Dr. Erich Werdermann for many years Curator of the Herbarium at the University of Berlin, Dahlem, has been appointed Director of the Botanic Garden succeeding Professor Mattfeld whose sudden death occurred recently.

California wild flowers, their beauty and use, an illustrated lecture by Dr. Philip Munz in the Natural Science Series, University of Southern California, Allan Hancock Foundation brought out the largest attendence in several years.

Dr. Lyman Benson author of the recently published "The Cacti of Arizona" was the speaker at the annual dinner meeting of the Southern California Academy of Sciences, in May. His subject, botanical progress in the world today, included a report of the International Congress at Stockholm.

"Agaves—potential source of a new drug" by Ladislaus Cutak is featured in the Missouri Botanical Garden *Bulletin*. Five photographs accompany the article, the cover page being *Agave Elizae*, named for Mrs. Alvin Berger.

PREPARATION OF FLOWERS FOR TRANSPORT

The quantity of cactus flowers sent Dr. Buxbaum in response to his request for material to carry on his studies was highly gratifying. Their condition on arrival left considerable to be desired, according to a recent report by Dr. Buxbaum. He believes that his instructions may have been incomplete. In *Mitteilung* for May he gives more explicit directions which should be useful to all who have occasion to consign flowers to institutions or botanists for study or for purposes of identification for the sender's individual benefit.

Certain details are of importance if flowers are to arrive at their maximum good condition.

First the state of developementis is of prime consideration. In general full grown flowers are required. If one wishes to remove pollen for propagations there can be no objection. This can be removed with a brush and stored away in a glass vial, closed with cotton for a stopper and kept for quite some time, especially if stored in a refrigerator.

If possible it is desirable to send of those varieties which are profuse bloomers that have buds in different stages of development, before their final unfolding. Such buds are easier to prepare but they do not show the open stigmas. Under no circumstances must the flower be in too advanced a stage; in such a case the sepals become hopelessly gummed together.

Preparing with ethel alcohol is recommended as best, before sending as the flower can be saturated. For this purpose the alcohol is diluted one third with water; otherwise the material becomes too brittle. The flowers remain in this solution until thoroughly impregnated. With small flowers this takes place in a few hours; large ones for instance like those of the gigantic Hylocereus require a week.

Flowers thus treated may be put in a small glass or larger one quite suitably; may be wrapped in waxed paper; over that tin or aluminum foil, then packed in a box.

If it is feared this is still insufficient for longer distances, absorbent cotten, soaked in the diluted spirits, wrapped in newspaper, may be put in with the flower. Generally, however, this latter precaution is not at all necessary, as the transported material is to be transferred on arrival to, alcohol at once, anyway.

Dry treatment is only to be used when the other method (alcohol) is impossible, since flowers are never as satisfactory as those prepared above. In no instance are the flowers to be cut up or pressed. The cut flowers are simply laid in the sun or in a warm dry place until they are completely dry. Later these may be regenerated sufficiently that they can be prepared under water. They may not according to the dry method be pressed, but should be packed and sent in a small box.

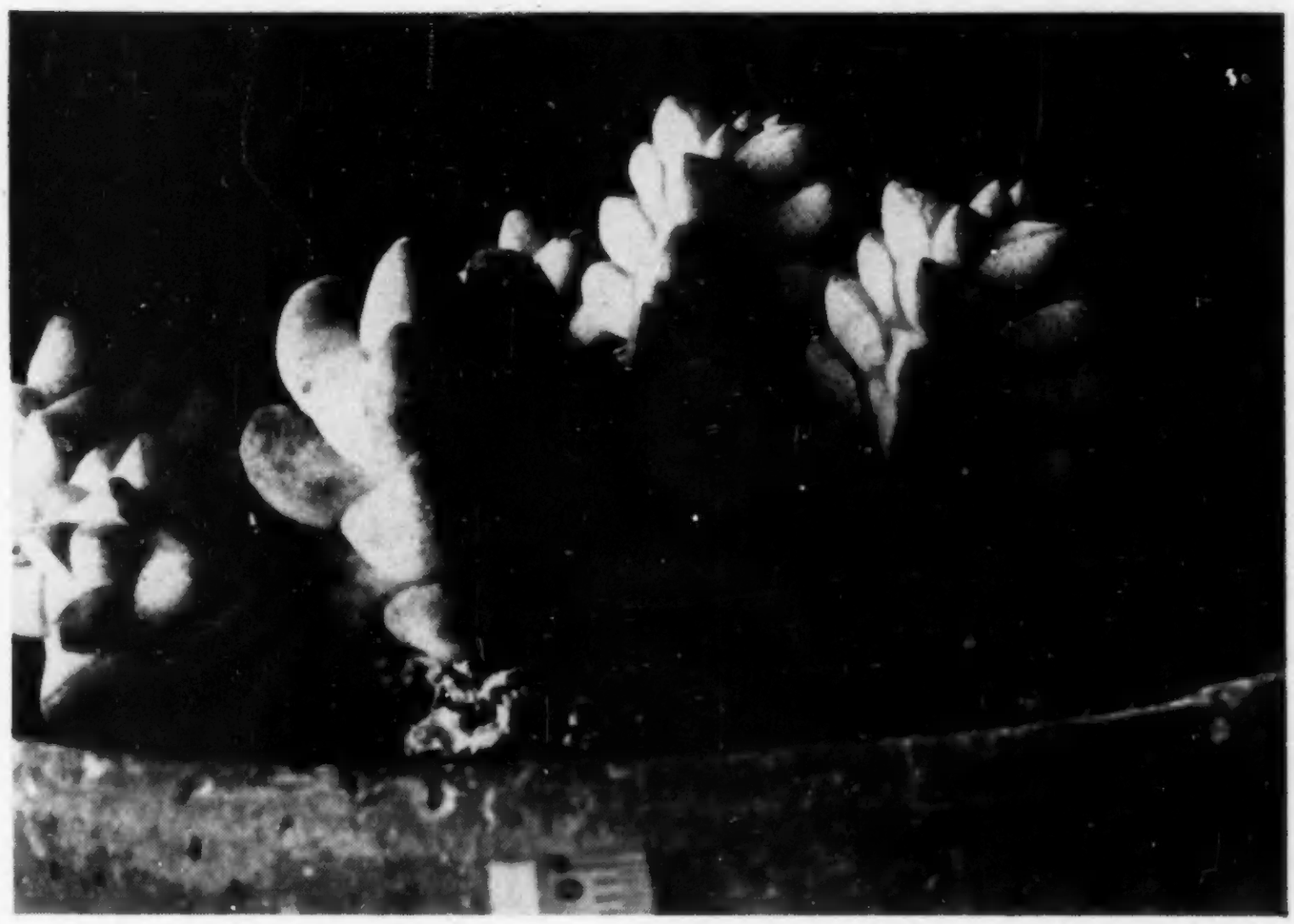
H. HERRE
Botanic Garden,
University of
Stellenbosch, South Africa

CRASSULA HOTTENTOTTA
Marl. et Schonl.

This rare species has been described in the Transactions of the Royal Society of South Africa vol. XVII, part 3, p. 256. It was found by Dr. Marloth on laminated rocks in the Richtersveld at a height of 1000 ft. As the Richtersveld is a reservation of the Hottentots, the name has been chosen because of that fact. The plants form small columns and come close to *Crassula cornuta.* They look also in some way like *Crassula deceptrix,* but our plants are much whiter in colour. A good idea of this is shown in our picture.

The plants are up to 5 cm high with a diameter of about 2 cm, and show the 7-8 pairs of leaves diminishing upwards. The leaves are opposite, ashy glaucous, subtesselate, up to 6 mm thick, ovate to obovate, obtuse, to 1.6 cm long and 1.5 cm broad at their base where the pairs are connated. The leaves are densely covered with subglobose papillae which do not form so visible dots as it is the case with *Crassula deceptrix.* The peduncle is formed on the top of the plants and may be 4 cm long. It bears the subcorymbose or subcapitate cymes. The flowers are small, the petals whitish, erect, while the stigmata are sessile or subsessile, terminal and the squamae are conspicuous.

In cultivation our plants must be kept like their relatives *Crassula deceptrix* and *Crassula cornuta* e.g. they want a fair amount of light and sun and must never have too much water, otherwise they die and rot. In full sun they become brownish-red at the tips of the leaves and along the margin, but this is quite natural. They are rare plants even in their home and something for the connoisseur who knows by experience how to handle such exquisite beauties.



CRASSULA HOTTENTOTTA Marl. et Schönl.

Photograph, by author, taken November 1949 in the University Botanic Garden at Stellenbosch, C.P. South Africa.

THE CACTUS JOURNAL

OF GREAT BRITAIN

20 Pages - Informative Articles - Well Illustrated

Published quarterly. 12 Shillings a year with membership 21 Shillings
Send subscriptions to Box 68, Pasadena, California or to
THE EDITOR, 7 Deacons Hill Road, Elstree, Herts, England

CACTI by Prof. J. Borg. (New and revised up to-date edition) Published 1951. **ENGLISH** **$6.00**

MESEMBRYANTHEMACEAE by Jacobsen & Volk. (Review in Desert Plant Life) German, 1950. ..... **$1.75**

KAKTEEN by A. Berger. (These copies are new and unused) German, 1929. **New Price** **$3.90**

GOETHE'S BRYOPHYLLUM by Dr. G. Balzer. German 1950. ..... **$1.50**

BROMELIACEEN, ANZUCHT UND KULTUR by Dr. W. Richter. German, 1950. ..... **$1.50**

STAPELIEEN UND KLEINIEN by A. Berger. German 1910. (Copies are new and unused) **$3.75**

BOTANICAL BOOKS

3066 GEORGIA ST., OAKLAND 2, CALIFORNIA

CRASSULACEAE

By ALWIN BERGER

Sonderdruck aus den NATURLICHEN PFLANZENFAMILIEN
Zweite Auflage

$10.00

DESERT MAGAZINE PUBLISHING COMPANY

CONTRIBUTIONS

FROM

The U.S. National Herbarium

WASHINGTON
GOVERNMENT PRINTING OFFICE
DESERT MAGAZINE PUBLISHING COMPANY
Box 68, Pasadena, California